SCIENCE

NEW SERIES
VOL. LXIV, No. 1667

FRIDAY, DECEMBER 10, 1926

ANNUAL SUBSCRIPTION, $6.00
SINGLE COPIES, 15 CTS.

SCIENCE

VOL. LXIV DECEMBER 10, 1926 No. 1667

CONTENTS

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 8, 1879.

THE UNITY OF LIFE[1]

HUMAN kind is slow to learn; what it acquires in one generation it loses in the next. Great truths evolving from everyday experience make but difficult way into the consciousness of the average person and eventuate but seldom in guided action. Nations rise and fall into decay and others follow the same course to the same end without profit from the evil example. For every generation and every individual, constant repetitions of the most elementary truths are required to save them from destructive courses. A mental cataclysm such as the recent war brought upon us is followed by questionings of all faiths and beliefs and even of evidences. All the old superstitions and instincts suffer a recrudescence. Intolerance and ignorance, but lightly held at bay even under the best of conditions, insinuate themselves anew into the thoughts of people and color their acts. Impulses which, in our pride, we thought were eradicated from the human mind rise out of the murk of the past and obtrude themselves upon our startled vision. The very foundations of civilization are indeed shaken in some countries.

Little wonder then that amid all this questioning and striving the conclusions of science are brought down into the dust of the market place and made the playthings of the ignorant. At a time when science is proclaimed the chief reliance of organized society in securing its perpetuation; when through its ministrations human life is materially lengthened, made more effective and enjoyable; when the uncertainties of existence and the terrors of the unknown are yearly being reduced in significance, then we witness the paradox of vicious and unreasoning assaults upon the methods and conclusions of science by legislative enactments to cripple its progress and to limit its teaching. It would seem from all this that science is in our day and generation, but not of it. This is no doubt largely the fault of scientists who have ever been inclined to become absorbed in the pursuit of knowledge and to manifest little concern with the use that is to be made of it. In extreme cases there are men who take pride in the thought

[1] Address given on the occasion of the installation of a chapter of Sigma Xi at New York University on March 20, 1926.

that no apparent application can be made of the results of their studies.

The time has come for a change in the relation of science to society. If indeed this knowledge is sound, if it represents reality and mirrors truly the circumstances and conditions of life, then it must enter into life and become a part of life. While it is important that knowledge be applied and made useful it is vastly more important that the method by which this resource is gained be made the habit of thought in daily living. Other civilizations have equalled or exceeded our own in art, literature and philosophy, but within a century we have learned more of the conditions of existence and have acquired greater control over them than have the peoples of all preceding civilizations. But what has been accomplished is only a beginning; the heritage of conscious participation in the order of nature remains largely to be won. That it can and should be won appears certain from what has already been accomplished. The chief assurance here lies in the demonstration of the efficiency of the means by which we have reached our present position. The so-called scientific method, which is only a refinement of the common-sense way of attacking any problem, is so obviously the proper way of relating ourselves to reality that its continuous application and development is definitely indicated for the future. Real progress in any human endeavor is dependent upon its use. Were it universally applied, society would be changed over night from a struggling, incoherent thing into a purposeful and directed movement forward toward our ultimate heritage.

Of all the contributions of science toward such an end no more unifying and fruitful a principle has appeared than the one which is commonly called the theory of evolution. Within half a century it changed entirely the method of thought of all civilized peoples. For a conception of blind chance and cataclysmic, destructive changes operating upon the earth and its creatures, there was substituted one of law, order and continuity. In a surprisingly short time this new view established itself in the minds of practically all scientists. Soon it made its way into the thought of other intellectual groups and finally became the guiding principle in all serious efforts to explain relationships on the earth.

And yet there was nothing new theoretically in this conception. Over and over again it had been suggested in opposition to its alternative of chance and cataclysm. This time, in the hands of Darwin, it became definitely established, not through speculation or the weighing of probabilities, but by actual observation and the accumulation of facts. To explain facts that he and others disclosed there was no alternative conception. The explanation remains a theory because it applies over extensive periods of time, of which we can have but brief personal experience. Only by long-continued observation can the mass of facts be made so complete that all doubts are removed and the theory becomes merely a complete statement of actual conditions or a law.

It is natural that in so comprehensive a thought as was presented by Darwin there should arise confusion between the principle involved and the explanation of its operation. The essential element of the evolutionary theory, whether applied to the earth itself or to its inhabitants, is that of continuity. Lyell, the geologist, demonstrated that the surface of the earth had not been formed by a succession of violent disturbances, but that it is constantly undergoing change, and, by the operation of these changes over long periods of time, all geological phenomena can be explained. Darwin applied the same conception in explanation of the varied forms of animal and plant life. That is, he conceived them to be, not so many separate creations, but a series of related forms having much in common, but showing differences due to time and to the reaction between themselves and their environment.

It is not my purpose here to enter into a discussion of the theory of evolution. I desire rather to ask your attention to a series of facts upon which the theory is based. I shall also depart from the usual method of presenting structural differences and relations and will review some fundamental conceptions of organization and function showing the unity of all forms of life. The discussion will, therefore, primarily concern itself with known facts regarding plants and animals, *as they now exist,* and not with speculations about how they came to be as they are.

We speak naturally and without effort of life—the unity of its nature and manifestations, as contrasted with the inorganic kingdom, is clear in all minds. Without knowing what, in reality, life is, we are so familiar with it through our own experiences and observations that we readily comprehend its range and significance. The term connotes all living things, large and small, simple and complex, plant and animal, ourselves included. There is no effort to exclude any extremes, high or low, from the all-inclusive designation which distinguishes the living from the non-living. It is this reality then that we wish to consider; it is into the nature of its unity that we would inquire.

Here perhaps the most striking thing is that life is not "without form and void" but is a very definite and concrete thing which always manifests itself through discrete units which we call individuals or organisms. It is possible to conceive living matter acting in formless aggregates of indefinite mass and

consistency, but no such conditions obtain in nature. The properties of life are those manifested by and through the harmonious cooperation of the differentiated parts of those highly characteristic complexes called organisms. But these entities do not constitute an infinitely graded series—they occur in groups the members of which show a greater resemblance in form between themselves than they do to members of other groups. Again, groups of the first order exhibit graded resemblances and constitute together a chain of forms passing from the very simple to the highly complex. It is to account for the relations of these kinds to each other that the theory of evolution was formed, and the basic assumption of this theory is that all organisms are essentially of a kind. Since the theory is to explain the origin of diversities it is natural that discussions regarding it should concern themselves with differences rather than with the underlying unity of which they are varied aspects. While, therefore, these diverse units differ endlessly in their form, they are only so many mechanisms for the performance of a definitely limited number of activities or functions.

Life, from this viewpoint, may be defined as a series of definite reactions between organisms and the physical universe in which they are placed. As the living units differ in various ways so do their common reactions in time, rate and degree, but in their fundamental nature they are similar. It may be well here to remind ourselves of the universal processes of life. First, we recall the unique capacity which living things have of taking foreign materials into themselves and transforming these into their own similitude. The plant, drawing in from the air the gas, carbon dioxide, and from the ground, water and certain salts in small quantities, by aid of sunlight combines these into food and then into plant tissue and in a year produces in one case a sunflower plant of ten feet in height, or by successive additions through centuries, in another builds the giant sequoia. The oceans swarm with minute plants which maintain themselves and grow in essentially the same manner. Directly or indirectly these are used by fish as food and becomes of their substance. At our tables the fish is consumed and converted into human flesh. The substance which I burn in my brain cells contriving the thought which shall picture to you this community of nature may be replaced by the converted flesh of the fish which recently swam in the Atlantic. Sooner or later, however, all living things draw upon the inorganic kingdom for the materials with which they build or replace waste, in order to maintain themselves and to grow.

Dependence of organisms upon this external world for all building and repair materials necessitates the possession of exact means for perceiving and appreciating the presence and character of these materials. Adjustments of many and varied character with the environment, inorganic and organic, demand the presence of these perceptive faculties. Because of a certain inherent property of irritability residing in living matter and specialized in various directions, reactions take place which serve to adjust the organism to the conditions under which it exists. While these reactions are specific in character in each case, they are fundamentally similar throughout. You pinch the leaf of the sensitive plant and it promptly closes; step upon the tail of the sleeping cat and the effect is much more immediate and vigorous. In each case an adverse condition, through the property of irritability, provokes a protective response. Continued adjustments to conditions of light, heat, sound, chemicals, etc., are the ever-present requirements for existence which make themselves known through this property of irritability.

It is not enough, however, that external conditions be perceived and appreciated—proper responses require spatial adjustments. The organism to reach the food it perceives or to escape a foe must be able to move appropriately. Thus we find that all animals possess within themselves some power of contractility, which, properly applied, results in movements. Plants generally have this response less highly developed, although it is present. The mechanisms by which animal movements are produced are extremely varied. There is the slow flowing progress of the protoplasmic blob, called the amoeba; the active darting of the slipper animalcule by means of countless vibrating hairs; the graceful rhythmic pulsing of the Medusa; the lightning flash of the squid with its reversible hydrostatic projector; the varied forms of fins and paddles of fish, amphibians and reptiles; the jointed limbs of insects, birds and mammals; the crawling motion of worms and snakes; the graceful winged flight through the air by insects and birds—these and countless other means of spatial translocation are all due to a common power of contractility inherent in protoplasm. These endlessly varied structural forms, expressing each in its own way an effort to set up a mechanism for producing motion, all owe their operation to the fundamental property of protoplasmic contractility.

But of all responses of organisms to their environment the one which continues the existence of the species or group by reproduction is most striking and characteristic. Not only does the individual maintain itself amidst all the vicissitudes of life, but it provides for the continuation of its kind. Indeed, this impulse often transcends all those making for self-preservation, and the individual life, which has

cost so much effort to establish and maintain, is unhesitatingly sacrificed for the young it produces.

Most remarkable, indeed, is this power of individual reproduction—the multiplication in almost infinite numbers of the same form of protoplasmic organization. Given an unvarying environment it is conceivable that any form of organic structure might continue through infinite time to perpetuate itself. Even with the tremendous changes through which the earth has passed since life began upon it, there are now living forms of animals that began existence millions of years ago in the Cambrian period. And yet it is certain that in all this innumerable host no two such individuals were exactly alike. Reproduction shows always the paradox of likeness and unlikeness. The extent of unlikeness, or variation, in reproduction is a property of each individual form, and in this may differ from time to time and under changed conditions. Since wide variation from type means extinction, it would seem that reproduction is exact, but this is a superficial view and takes no cognizance of the immense losses during development. The possibilities of variation are great in many forms that appear exact in reproduction. Thus, for example, all insects have six legs, but certain strains of flies, under appropriate conditions, may be made to produce individuals with twice this number. In this case temperature determines whether an individual shall be like all other insects in its number of legs or whether it shall be a new kind with a double set.

Thus we see that all living things make a like series of responses to the conditions under which they are placed—in other words, they are adapted to their circumstances of life. These physical conditions differ in many respects, to be sure. Some organisms live in water, some on the land; some are fixed and immovable, others have great powers of locomotion through the air or water or over the land; some love the light, others shun it; what is one man's meat is another man's poison and so on. The range of adaptation in each case is definitely limited, but within this we note that the character of the response determines the character of the organisms.

There comes a time for each form of life when conditions may pass beyond the power of adjustment and extinction follows. Millions of different species have thus finally disappeared and are known only by their fossil remains—how many other millions have passed leaving no record is beyond guess. In a given case some very small cause may be sufficient to terminate existence, while other forms thrive. But when all is said and done the circumstances that determine the existence of all life are very narrow. Should the light of the sun fail us the earth would soon be lifeless. The removal of water or carbon dioxide would produce a like result. Indeed, as Henderson has shown, only the peculiar properties of these compounds, among all physical and chemical conditions on the earth's surface, are competent to meet the requirements of living things.

There is here no choice as between ourselves and the lower animals. Our lot is their lot. We stand or fall with them. Remove one of the essentials of life and we perish as miserably as the lowest creeping thing. We differ only in our capacity to understand and to take advantage of circumstances, but our nature and requirements are the same as those of all life.

There are many interdependences in life, so that it seems a very diverse affair. Thus only the green plants are able to take their food directly from inorganic sources—they constitute the immediate contact between living and non-living things. Animals, either directly or indirectly, feed upon them. Carnivorous animals could not live were there not herbivores to transform plant tissues into an appropriate food. There are a great series of symbiotic and parasitic relations which are absolutely essential at the present time to the existence of many kinds of organisms. Some plants require brilliant sunlight, others live in the dark; some grow in hot springs, others in water from melting ice; some are found only in desert regions, others thrive in an atmosphere saturated with water.

These many apparent diversities are, however, only modifications of a common series of conditions. Water is an absolute essential to every form of life—the method by which it is applied may vary greatly. Oxygen for the consumption of waste products is a necessity whether it is taken into the blood from the water through gills, or from the air directly by means of tracheae or lungs. The same requirement is made by plants.

In addition to these basic, underlying similarities in the reactions of all living things, there are others of more limited range, but of great consistency where found. Thus in the higher animals there are a series of psychic responses, eminently characteristic of advanced development. These, in most cases, can be traced back to more primitive states in lower forms. Hunger, the desire for food, is always present; love, the attraction between individuals, particularly of opposite sexes, is almost universal; fear, the impulse to avoid what is inimical or dangerous, finds expression almost as commonly. How impelling are these impulses and how they link us to the brutes we are often unpleasantly reminded when conventions fail and we are faced by primal conditions.

How is it, then, if there be such an underlying similarity of character in all organisms, there should

exist such a diversity of form? This question looms large in all considerations of organic relations. The derivation of one form from another is the central element of evolutionary theories; the separate and independent production of each form is the essence of cataclysmic theories. Form, however, is only an expression of functional capacity. As we have seen, all manner of organisms have been able to sustain themselves under practically identical conditions, by the performance of a like series of processes. The rate, degree and character of these activities are very different, however, and are dependent upon the structures which perform them. Light perception is common to most organisms, but the formation of a perfect image is possible only in the presence of an organ like the vertebrate eye. Some sort of coordination of functions is accomplished by the central nervous system of all animals, but extreme precision is possible only under the operation of a well-developed brain. Speculations regarding the plan of nature and the place of different forms of life in it waited until a human brain was formed. It is of greatest significance to note that not only is there a common series of processes in all animals, but that, for a given one of these, a definite portion of the body is set apart for its special performance. This part is most alike in forms most closely related, *i.e.,* in a species all members are so much alike that they are sometimes individually indistinguishable, while small differences appear in closely related species and larger differences as we depart further. Structure then marks the degree of functional capacity and all the varied forms of life are expressions of a series of functional developments. It is quite as useless to separate a consideration of structure from function as it is to attempt a consideration of organisms apart from their environment. Since, however, the measure of performance is so well expressed in structural mechanisms it is right and proper, as well as expedient, to measure organic relationships in terms of structural complexity. But for our present discussion we may note that in the face of the overwhelming diversity of forms producing species by the millions, there prevails throughout the operation of a limited number of processes common through all the diversity. Complexity of mechanism is then the visible evidence of underlying specialization and refinement of the all-pervasive and essential functions of living matter.

The essential unity of life, so well indicated by the universal exhibition of a few fundamental and necessary functions, is marked also by a structural character, likewise practically universal in all organisms and therefore strongly suggestive of a common nature. From earliest times thoughtful men tried to conceive the intimate nature of their bodies. It was readily perceived that they are not homogeneous, for bones, muscles, tendons, blood, etc., were readily noted, but the question is insistent; is there something more elementary back of all these things? Not until the human eye was strengthened by the invention of the microscope was this question answered. Then it was found that there are elementary structural units out of which the body is composed, and that these are the building blocks of all organisms—plants and animals alike. They differ between themselves in form and size, and by the modification of a common series of parts, great diversities occur, but fundamentally these units, or cells, are essentially alike and there is already a new science, cytology, which considers the nature of cells in general and the peculiar modifications of various types.

It would be quite impossible to overestimate the significance of the fact that all organisms have a common structural unit, because it means that the operations of living things can be analyzed in terms of the functions of cells. Different functions are found to have their own peculiar modifications of the cell, so that we study, for instance, the contractility of muscle by observing the form of the cell which is the unit of muscle structure. In turn we compare the contractile cell with the one which has been modified for perception of stimuli or for secretion or for support. Thus we learn that the external visible differences in the bodies of plants or animals represent the summation of internal cellular specialization, designed to exhibit in a marked degree one of the general properties of living matter possessed in common by all cells. Roughly, the condition is comparable to what an architect would find in the study of the structure and properties of houses if they were all built up of bricks of various kinds, each designed in size and shape for a particular purpose. Certain of these would be fitted to form the outer, protecting walls; others would be adapted for the finish of the interior; still others would be shaped to produce tubes and ducts and so on. One familiar with these conditions could then recognize from what part of a house any form of brick was derived, and if the parallel held, could identify the particular kind of house in each case.

This would be interesting and remarkable enough, but it is simplicity itself compared with what we find in living things, for here every plant and animal at one stage of its existence consists of but a single one of these units or cells. There are always specific differences at this time, but they are often so minute as to be entirely indistinguishable. A man at this period of his existence differs in no recognizable way from the meanest beast of the field at a corresponding period and in only minor ways from the grass upon

which it feeds. The unity of living things is indeed most complete at this time.

But each of these kinds of temporary one-celled organisms has its own inherent character which becomes revealed by a series of processes much alike in principle in all animals and, to a lesser degree, in plants as well. A common start and a common series of processes reveals in the end inherent though invisible differences, and a man emerges in one case and a beast in another. Step by step in development complexity increases and diversities appear, but after all what we witness is the modification of a common series of structural parts principally by refinement and increased complexity in the higher forms. Starting as one cell the individual becomes two-celled, then four, eight and so on until millions and millions result. These cells present in each case a definite arrangement at each stage and inevitably emerge in a complex, whose pattern, to the most minute details, is like that of other members of that group of organisms. Cells appear, take their position, become modified in form, reproduce themselves, become coordinated with unlike cells and so build up the incomprehensible complexity and unity of the individual.

Now it must be remembered that these cells are microscopic in size; therefore, the field of operations and the mass of material involved are exceedingly small. Yet with the microscope we can discern an inner organization of exquisite beauty and nicety which may be traced to finer and finer details until the limit of our observational power is reached. Undoubtedly this continues even to molecular structure. But here again the phenomena are coextensive with the immense variety of life. Studies made upon plant cells are used as a basis for generalizations applying as well to animals. Diversity always, but equally, unity.

Nowhere perhaps in all nature is the community of her forms more impressive than in the orderly movement of the microscopic cellular parts wherever found. Particularly is this true when we consider those cells which are designed for the specific function of reproduction. The very fact that in multicellular plants and animals there are certain cells set apart for the perpetuation of the species is a striking enough indication of the existence of a common plan governing the nature and operation of living things, but when the exact correspondence in most minute details is observed the conviction is overwhelming that only the strictest community of nature could account for such correspondences.

Since apparently we deal here with the attributes of living things in their simplest and most obvious common terms it may be well to examine into these conditions, even though they may present unfamiliar aspects and involve us in the discussion of facts beyond common observation. Let us regard then the beginning of an organism—any one will do, in principle, for all. This, it seems to me, is the clearest evidence of the unity of life that we find on all the structural side. Such a representative of all organisms, in its earliest stage, is a single cell formed by the union of two cells—one derived from an individual with female qualities and the other from one with male qualities. It is a microscopic, spherical mass of a transparent jelly-like substance, and, so far as any one but a person very familiar with this particular kind of cell could tell, might be any one of thousands of similar beginning organisms. It is, however, just as much of its own kind as the latter individual into which it develops, marked and characteristic as that may be, but at the same time is a representative of all organisms at this stage.

When we come to pry into the inner nature of this seemingly simple, one-celled individual, we find it unbelievably complex—the diversity of many and varied parts, later to appear, is here compressed into the apparent simplicity of a few parts, and there is no visible hint of their relation. The consol of a pipe organ is a comprehensible object of a purely mechanical nature—certain keys in a definite position, some stops and levers within reach and a cable of wires to the banks of pipes. Such an organ may be operated mechanically by a perforated sheet, and the musical effect will depend entirely upon the pattern of openings in this sheet. The correspondence between the mechanical guide and the resulting combination of musical notes is, of course, exact, but is in altogether different terms, and can be understood only if the relations of all the parts are known. In a remote way this indicates something of the relation between the undifferentiated egg and its product. It possesses a pattern of its own, which, playing upon the common properties of the living substance, produces inevitably a certain combination of the parts common to living things. This guiding pattern of the egg is indicated by recognizable inner structures, but the nature of the correspondence is not known. Our only hope for knowledge of developmental processes lies in a study of this cellular pattern and already we have made some progress.

Now we have seen that all life represents a series of common reactions to a somewhat common environment; that it is exhibited through a wide range of structural mechanisms; and that all these varied structural forms are made up of a common structural unit. We have next to note more in detail the statement already made that these common units are constituted of a common substance—protoplasm. Indeed, all the series of activities which run through the manifold

forms of plant and animal life, and bind them to unity because of their likeness, are only the functions of their constituent substance. This, as Huxley termed it, is "the physical basis of life." Much is known of this protean material, but its vital characteristic remains unknown. Why a particular form of combination of a limited number of ordinary chemical elements should produce a compound capable of metabolism, perception, movement and reproduction in all their manifold aspects yet remains a mystery. In inorganic substances there are certain analogies to the properties of protoplasm, but they remain analogies and exist in no such combination or degree as characterizes living matter. The physical forms of some plants and animals may be simulated by minerals or salts; the phenomenon of irritability has a remote counterpart in the varying responses of metals to heat and to physical stress; movements of various sorts occur in non-living substances; but nowhere in the realm of the inorganic do we find the capacity to take up foreign substances, and to make these over into the varied materials characterizing a given substance so that they compensate for a specific loss or add a specific gain. Above all only protoplasm has the power to so enlarge and organize a given microscopic bit of itself as to produce an aggregate similar to the one from which it was derived—an organization frequently of the most incredible precision and complexity.

No; protoplasm is unique—it is as yet incomprehensible, but its coextensiveness with the phenomena of life is certain. From the dust of the earth it must have come, because in it are only the elements of the earth—there is nothing there which is exclusively its own—but how the divine fire fused these into so wondrous a form, that phase of it which composes the human brain has not yet been able to conceive. Since, however, the constituent chemical elements are not unique, the inherent peculiar properties must be sought in the arrangement of the elements. At once we find that protoplasm has many of the characteristics which chemists recognize in that large group of gummy, glue-like substances they call colloids. Time does not permit a discussion of the nature of colloids, but it is sufficient for our present purpose to note that protoplasm, from whatever source derived, exhibits many of the properties of these substances. That is to say, there is unity in the chemical nature of all protoplasm.

There are many ways in which the unity of protoplasm shows itself aside from the broad likenesses physically and chemically already mentioned and in the general physiological functions which are its attributes. Some of these are of such a nature as to indicate that the interdependence of the differentiated protoplasmic elements set up in one kind of an organism exist in others. For a very long time it has been known that the varied activities displayed by the organs and systems of an individual are made to work in order and harmony through the integrative action of the nervous system. Much more recently it has been learned that there is, in back-boned animals, at least, another system with somewhat the same office. There are a series of glands known as ductless glands, each producing a characteristic secretion and having a specific action. Two of these, situated in the neck region, and one at the base of the brain, have much to do with the rate and character of growth. Sometimes these become diseased and thus betray their relation to growth.

Because of external conditions the inhabitants of certain regions are often subject to insufficiency in the action of one of these glands—the thyroid. In such cases growth is disturbed and hindered and individuals known as cretins result. Body and mind both are distorted and an otherwise normal individual is condemned to be a misshapen dwarf and idiot—all because a certain part of his body failed to supply an essential element of growth. Now if all organisms were unlike, or if man stood apart in nature, such a case would be hopeless unless the missing substance could be contributed by another man, for here is a protoplasmic product of a very specific sort so potent that only minute quantities make all the difference between normal growth and idiocy. But let such a prospective cretin be supplied during growth with the thyroid substance from whatever source and he puts aside the fate of mental inadequacy and becomes a normal man. The capacity to take from the environment certain substances, the function of a particular part of the body, lacking in man, is assured by supplying a substance elaborated in a similar part of the body of a sheep, a whale or what not. The difference between normal human mentality and its opposite is thus measured by the contribution of a lacking part by one of the lower animals.

Along with the evidences of a community of nature throughout the animal kingdom there are indications of graded relations quite as marked. These are very interesting because they give a scientific basis for the ancient conception expressed by the term "blood relations." Why it was ever supposed that the character of the circulatory fluid would betray relationship I do not know, but it turns out to be a fact. This evidence of protoplasmic specificity is of two sorts. First, there are the investigations of Reichert and Brown upon the form of haemaglobin crystals from which it appears that different kinds of animals are marked by characteristic crystallographic types and that forms conceived by other criteria to be related

are found to have geometrically similar haemaglobin crystals. Thus we have in the blood of all the higher animals a peculiar substance whose vital function it is to take the oxygen from the air and make it available throughout the body for the burning up of materials to produce energy. They are alike, or related as is shown by the common characteristic. Here is an evidence of relationship in a matter of fundamental importance. The common characteristic of vertebrate structure distinguishing a great series of forms, which, in turn, are of almost infinite variety in their modifications, is paralleled by the existence within their bodies of a common substance likewise exhibiting geometrical variations of its crystals in conformity with the variations in body structure.

Then there are those subtile distinctions, comparable to the most delicate chemical tests, displayed by the reactions of soluble substances in the blood plasm. These are extremely varied, but highly specific so that it is possible to detect the presence of any form of protoplasm in much the same way as the chemist identifies inorganic substances. By these precipitin and agglutination tests not only are particular protoplasmic forms recognized but the degree of specificity indicated. Thus it is possible, for example, to say that a certain sample of blood is not from a dog or a horse, but whether it is from a man or an anthropoid ape can not be told with certainty, so similar is the character of reaction. The highly exact nature of these responses is indicated by the phenomena of immunity. Here a given kind of protoplasm, gaining access to the circulatory system of a foreign organism, provokes changes which produce certain antibodies which, in the future, inhibit the repetition of this action. These antibodies introduced into the body of still another kind of organism also protect it from the reaction. In every case, however, the result is specific and immunity against one kind of protoplasm confers no protection against others. These tests show us, first, that the protoplasmic substances of different organisms are specific in their character; and, second, that the relations between them are not discontinuous but graded. They identify particular kinds of living substances on one hand, and show their positions in a series on the other. With wide enough variation, no reaction occurs—between organisms shown to be nearly related by community of form the effects approach uniformity—which is only another way of saying that the form of the body is an expression of the character of the substance composing it.

A most striking example of protoplasmic relations is shown in the phenomena of anaphylaxis. In producing antibodies for a foreign protoplasm, the substance is introduced into the blood in successive doses until the effect is complete, the reaction becoming gradually less. If, on the contrary, only a small injection is given and then no other for an interval of ten days a second injection may then produce violent and fatal results. The first introduction of the foreign substance, instead of conferring an immunity, sensitized the individual to the alien material and results, on the second dose, in a reaction of such intensity as sometimes produces death in a very few minutes. The sensitivity produced by the first dose is specific, that is to say, a particular kind of protoplasmic substance in minute amount produces upon another an effect, the presence of which is demonstrated by the anaphylactic response. Like the precipitin reaction this is an indication of the highly developed specific character of different protoplasms and their products.

If chemists are justified in the identification of particular substances by their reactions and of grouping these by similarities, thus shown, biologists are equally justified in taking as evidence of specific character the occurrence of precipitin and agglutination reactions, the production of immunity and the constancy of crystal form in the red coloring matter of blood and of establishing relations through the degree and character of resemblances they exhibit. Any one of these tests is highly suggestive, the concordance of all of them is convincing; and the exactness of their agreement with the known facts of structure and behavior of the organisms from which they are derived is demonstrative on the one hand of the specificity of organic groups and on the other of their graded relationships. Specificity is always admitted—no one disputes the existence of "kinds" of plants and animals. A rose is not confused with a violet or a dog with a horse—their diversity of nature is our common experience. Subconsciously also we realize the community of their natures, because all of them we class as living things. We do not hesitate either, in these general terms, to ally ourselves with this world of living things, but when it comes to specifying degrees of relationship we may draw the line. While we may be quite willing to admit our derivation from the inanimate and formless dust of the earth we recoil from the thought of kinship with non-human forms even though they show likeness part by part to our own bodies and are made up of substances which, with most extraordinarily delicate tests, can not always be differentiated from similar ones within us.

Conceiving all those qualities which appertain to living things can we logically admit the specificity of groups and deny their relationships? Are these indeed not two ways of expressing degrees of relation? No two organisms are ever exactly alike. If we view the mass of living things and attempt to sort them into groups we take those most alike and call them one "kind," and another with slightly different concord-

ances as another "kind" and so on. But no two people will agree exactly in their estimates of resemblances and differences. The groups are mental concepts, not realities. When one stops to consider the matter well, the astonishing circumstance about living things is not their diversity of form, protean as this may be, but the unity in the performance of a few common actions throughout this infinite variety of form. These functional characteristics are ever present and always observable—they are indisputable and convincing evidences of the common tie which binds all living things together—their operation, so precariously dependent upon a few, strictly limited physical conditions upon the earth, throws the fate of all into one balance. On the other hand, the continuity of form is not to be observed with any fullness. By far the greater number of "kinds" of plants and animals are extinct and of these only a few are known. Of the living, new ones are constantly being found. Our knowledge of the range and continuity of form must always be fragmentary. Form, indeed, is, in its nature, a matter of discontinuity; but function is continuous, always observable and susceptible of quantitative measurement. There is no escape from the conclusion that every living thing is kin by nature of its vital activities with all other living things. The unity of life is a reality. This is the important thing in all our thinking. We will always strive for fuller knowledge of the relations in time of the many forms under which life presents itself, but we do this in the realization that we can never know in full detail the whole story. It is beyond the compass of human experience.

C. E. McClung

University of Pennsylvania

THE ANNUAL PRIZE AWARDED BY THE AMERICAN ASSOCIATION

It was at the Cincinnati meeting, in January, 1924, that the first of its annual prizes was awarded by the American Association. Since that time two other prizes have been awarded, one at the Washington meeting, in January, 1925, and the other at the Kansas City meeting, last January, and the fourth prize in the series will be awarded at the approaching Philadelphia meeting in convocation week. The three awards thus far made are as follows:

1. To Dr. L. E. Dickson: Researches on algebras and their arithmetics.
2a. To Dr. Edwin P. Hubble: Researches on cepheids in spiral nebulae.
2b. To Dr. L. R. Cleveland: Researches on protozoan parasites of termites.
3. To Dr. Dayton C. Miller: Researches on the ether-drift experiment.

The sum of $6,000 was given to the Association, by a member who wishes his name withheld, to be awarded in six annual prizes of $1,000 each. Three future prizes are at present cared for. The second award was divided equally between two prizemen, as shown above, but future awards will not be divided. The award is made at the end of the annual meeting, to the author of some noteworthy contribution to science, presented in the program of the meeting. There is no competition in the usual sense. Because contributions in different fields of science are generally not commensurable, it is not intended that the prize paper is to be necessarily the best of the meeting. It is to be one of the very good ones. Membership in the association is not considered in awarding the prize and the programs of all the organizations that meet with the association at the annual meeting are considered, as well as those of the association itself. This feature of the meeting greatly increases interest and enthusiasm and it has clearly demonstrated the wisdom as well as the generosity of the donor.

The award is made by the committee on prize award, named by the council or by its executive committee. This year the membership of the committee on award is as follows:

C. E. Seashore, University of Iowa, Iowa City, Iowa, *chairman.*

Otis W. Caldwell, Lincoln School, Columbia University, New York, N. Y.

C. B. Davenport, Station for Experimental Evolution, Cold Spring Harbor, Long Island, N. Y.

Lauder W. Jones, Princeton University, Princeton, N. J.

C. F. Marbut, U. S. Department of Agriculture, Bureau of Soils, Washington, D. C.

Nominations for consideration by the committee on award are received during the meeting, from secretaries of sections and secretaries of societies meeting with the association. From these nominations and from additional ones that may be made by members of the committee itself, the committee on award elects the prizeman for the meeting.

Burton E. Livingston,
Permanent Secretary

CURTIS GATES LLOYD

On the morning of November 11, Curtis G. Lloyd died at Bethesda Hospital in Cincinnati at the age of 67. During a lifetime that was largely devoted to scientific work he built up in Cincinnati a great mycological museum. It would be impossible to give an accurate estimate of its extent. More than fifteen years ago he printed the statement that there were then ten times more Gasteromycetes in his museum

than in all other museums combined. The museum contains many thousands of specimens, carefully preserved, mainly of the type of fungi that make good museum specimens. He did not solicit the fleshy fungi, preferring to confine his studies to those which were not so materially altered by drying. Specimens came to him from all parts of the world, perhaps fewer from Europe than from other foreign countries.

Together with his brothers, John Uri Lloyd and Nelson Ashley Lloyd, he founded the Lloyd Library in Cincinnati. This library contains more than 52,000 volumes, and is foremost in works on materia medica and mycology. Of the 26 bulletins of the Lloyd Library, six were mycological and his own. The other bulletins were works of reproductions of rare prints, the pharmacy series and the entomological series. Mr. Lloyd's own special publication was titled *Mycological Notes*. Of this he issued 75 numbers, the last issue being of the whole series 75, of Vol. 7, No. 10. In addition to this he published special monographs, numerous letters and circulars.

The University of Cincinnati last June conferred upon him the honorary degree of doctor of science.

Dr. Lloyd was of unique personality. He was thoroughly devoted to his chosen field of science. He was unsparing of his own labor, independent in his methods, and intolerant of sham. He was impatient with all the time-wasting devices of the priority hunters, because he deemed them a hindrance to science. He deprecated "species-grinding"; but he travelled the world over visiting the museums and the collecting grounds in many lands in order to know species thoroughly. In spite of the prevalent rules to the contrary, the names of describers of species were not appended to scientific names in his publications. He believed with Darwin that this sort of cheap notoriety places a premium of slip-shod and hasty descriptive work, and he would have none of it. Probably the world at large will tire of it soon.

Dr. Lloyd was a real promoter of conservation. While many others talked wild-life preserves, he quietly brought them into existence: first, a fine area of virgin forest near his boyhood home at Crittenden, Ky., which he filled with wild flowers. Then three of the choicest bits of nature near to Cornell University: one an area of cold, upland bogs near McLean; another a wild flower preserve in a woodland near Slaterville Springs; and the third a region of potholes in beech woods at Ringwood Hollow. All these he placed in the permanent keeping of a board of trustees for the benefit of the public.

Dr. Lloyd was a man of great personal kindliness. The Cincinnati *Enquirer* says of him:

He never married, but was a great lover of children, and every Christmas piled stacks of toys and gifts in the Lloyd Library and distributed them to poor children whose names he obtained from the Salvation Army. He also built a Community House for the folk of his native village.

J. G. Needham

SCIENTIFIC EVENTS

THE INTERNATIONAL OFFICE OF MUSEUMS AT GENEVA

An International Office of Museums is being organized at Geneva as a sequel to action taken last summer by the International Committee on Intellectual Cooperation of the League of Nations. According to *Museum News* this new office will undertake to form ties of understanding and mutual helpfulness between museums throughout the world.

The task of organization is in the hands of the International Institute of Intellectual Cooperation, the committee's working agency which is financed by the League of Nations, but the Office of Museums is to be an independent body which will find its own resources and develop its own program.

The office was projected last spring. In the course of a month the institute had canvassed the museums of Europe and had secured some three hundred approvals of the general plan. The American Association of Museums gave its adhesion through Dr. Vernon Kellogg, permanent secretary of the National Research Council, and chairman of the American section of the committee. The various memoranda were brought before a Sub-Committee on Arts and Letters, which body offered the following resolution:

The sub-committee notes with satisfaction the numerous adhesions which have reached the institute to the scheme for the establishment of an International Office of Museums. It believes that the time has come to decide upon the institution of this office and to indicate as follows the duties which it might be instructed to perform:

(a) To encourage between the museums, either by districts or on a national or international basis, relations of mutual acquaintance and assistance, and for this purpose to establish gradually a concise catalog of the museums of the world, to encourage the establishment of national lists and eventually of an international list;

(b) To encourage gifts and loans to museums from individuals;

(c) To make known the important provisional committee of an international character, composed of fifteen members at most, dealing in particular with associations of friends of museums.

In order to relieve the institute of anything which might involve a financial responsibility, an endeavor should be made to create an autonomous association which would assume responsibility for expenditure and receipts.

The sub-committee instructs MM. Destrée, Focillon,

Luchaire and Oprescu and Mlle. Vascaresco to proceed with the carrying out of the present resolution, and, for this purpose, authorizes them to make the appointments contemplated and to take any useful steps, and in particular to arrange a meeting at Geneva of the directors of the important chalcographies for the conclusion of the agreement relating to engravings. (Paragraph (c).)

The method which the office will endeavor to apply in its work is an experimental and practical method, documentation being subordinated to action and preference being given to practical results within a limited sphere of action rather than to general schemes which may be easy to draw up but are difficult of realization.

This proposal was approved by the committee at its eighth plenary session in July, and was published as resolution XV in the report of the committee. In accordance with the action, a meeting of the directors of the important chalcographies was held in Geneva in October.

THE HOOPER FOUNDATION AND THE RESEARCH LABORATORY OF THE NATIONAL CANNERS ASSOCIATION

THE Hooper Research Foundation of the University of California, under Dr. Karl F. Meyer, has been asked to take charge of the bacteriological laboratory of a $100,000 research plant constructed by the American Can Company for the National Canners' Association.

The new research laboratory, a three-story building in San Francisco, will be devoted to the improvement of canning methods in the Pacific Coast States and Hawaii and to the safeguarding of the public wherever products from the district are sold.

The plant is completely equipped with chemical and bacteriological apparatus. Among the more important items are a complete hydrogen-ion outfit, complete equipment for heat penetration studies, microscopes, electric ovens and furnaces, apparatus for thermal death rate determinations, a refractometer and an electric refrigerator.

An advisory committee is in process of selection by Elmer E. Chase, of San José, Calif., president of the canners' association, and Leonard E. Wood, of San Francisco, vice-president, in cooperation with Dr. Meyer. A number of men from the Washington laboratory of the canning association are expected to aid in carrying on the work of the new plant.

The university is particularly interested in studies of botulinus, and will carry out investigations on this subject. The State Fish Commission, also, has arranged a $15,000 fund donated by fish canners for special research in this branch of the industry. All members of the canning association have been invited to send in their problems to the laboratory for scientific study.

THE AMERICAN ASSOCIATION COMMITTEE ON THE AGASSIZ BUST

A SPECIAL committee has been named by the American Association for the Advancement of Science to solicit funds for a bust of Louis Agassiz, to be placed in the hall of fame of New York University, with the busts of the other great Americans who have been similarly honored. The bust is to be described as a gift from members of the American Association for the Advancement of Science, and others.

The undersigned have been named as the special committee for this project. The committee feels that the leading scientific society of America should rejoice in thus honoring one of the most accomplished leaders in science, at the same time one of the greatest of teachers and, moreover, for many years an active member of our association. Agassiz was president of the American Association in 1851. The needed sum, about $3,000, can not be appropriated from the treasury of the association and must be given by individual members. Our membership is so large that the sum should be readily made up by small individual contributions.

Those contributing may send checks to any member of the committee or to the Washington office of the association, Smithsonian Institution Building, making them payable to "American Association for the Advancement of Science, Agassiz Bust Fund."

David Starr Jordan, *chairman*	Leland O. Howard
Liberty H. Bailey	Herbert Spencer Jennings
J. McKeen Cattell	Vernon Kellogg
Cornelia M. Clapp	John C. Merriam
F. V. Coville	Henry Fairfield Osborn
Barton W. Evermann	George H. Parker
J. Walter Fewkes	Charles D. Walcott
Samuel Garman	Edmund B. Wilson

TESTIMONIAL TO PROFESSOR WILLIAM HENRY HOLMES

As a testimonial to Professor William Henry Holmes, director of the National Gallery of Art, on the occasion of his eightieth birthday, on December 1, a volume was presented containing one hundred and fifty personal letters of felicitation from intimate friends and those colleagues and co-workers who during the past sixty years have been closely associated with him in the fields of geology, anthropology, exploration and the fine arts. The dedication of this volume, by Dr. Marcus Benjamin, reads as follows:

Out of the West came the boy, and we can fancy in those long ago days that he had a natural instinct for things beautiful, such as pleasure in the brilliant coloring of a fragrant flower; joy in watching a gay butterfly flitting to and fro in the air; following the sunlight as it glistened on the babbling brook or the foaming water

dashing over the rugged rocks; listening to the music of a bird; or perchance enjoying a wonderful sunset with its reds and yellows darkening into violets and purples. And so the boy learned color values and became an artist.

The happy days of boyhood soon passed into adolescence and manhood, and with his powers of close observation trained to study nature, Holmes concentrated his natural talents on the study of land formations. The details of rocks and strata were differentiated and he learned nature in a new way as he crossed the continent in the service of our national surveys. And the boy artist became the man geologist.

Evolution was the spirit of his time and from investigating the geological horizons of our great continent, he sought higher objects and turned his attention to the highest form in nature, which is man. The beginnings of culture attracted him. Original forms of weaving and primitive pottery became the objects of his study. And so the geologist progressed and became the anthropologist. His classical memoirs on the arts of early man are still accepted as the last words on the subjects of which they treat.

Then more years came to him and he was advanced to the charge of the Bureau of American Ethnology. His mission was to direct the studies of his disciples for the purpose of increasing and diffusing the knowledge of which he was the accepted master. And so for a decade or more the results of the progress of his favorite science were given to the world in the annual reports and bulletins issued under his supervision.

Still in the prime of his days and rich with the art instinct of his early life, cultivated and developed by the experience of many years he turned again to the ideals of his boyhood dreams and became director of the National Gallery of Art under the supervision of the Smithsonian Institution. And his duty since has been the privilege of selecting the art productions of his many contemporaries and arranging them for the edification of the public. May he long continue active in the prosecution of this work.

Of honors he has many, but why chronicle the collegiate degrees that have been conferred on him or the memberships in scientific or artistic societies that he has received? His election to the National Academy of Sciences and to the presidency of the Cosmos Club tell the story. They are all negligible when we think of the man.

Gentle and kind, sweet and true, he has given always the best that he had to his fellows, and our earnest prayer is that he may long abide with us, so that the world may continue to be made more beautiful by his splendid influence.

SCIENTIFIC NOTES AND NEWS

THE seventy-fifth birthday of Dr. John M. Coulter, emeritus professor of botany at the University of Chicago, was celebrated on November 20, at the Boyce Thompson Institute at Yonkers, N. Y., where Dr. Coulter is now engaged in research.

THE seventieth birthday of Dr. William E. Ritter, president of Science Service, first director of the Scripps Institution for Biological Research, La Jolla, Calif., and professor emeritus of zoology at the University of California, was celebrated at a dinner given in his honor at the Cosmos Club, Washington, on November 26. Gathered to honor Dr. Ritter were Mrs. Ritter, Mr. and Mrs. Robert P. Scripps, Dr. and Mrs. Edwin E. Slosson, Dr. and Mrs. T. S. Palmer, Dr. Vernon Kellogg, Dr. J. C. Merriam, Dr. J. McKeen Cattell, Mr. and Mrs. Watson Davis, Dr. Frank Thone, Mr. James Stokley and members of the staff of Science Service. Letters and telegrams of congratulations from many of Dr. Ritter's friends and former associates were read and he was presented a souvenir book in honor of the occasion.

DR. JACOB G. LIPMAN, dean and director of Rutgers University and Experiment Station, has been elected a corresponding member of the Czechoslovakian Academy of Agriculture.

DR. ALEXANDER WETMORE, assistant secretary of the Smithsonian Institution, has been elected honorary member of the Sociedade Protectora dos Animaes de Santos e São Vicente, of Santos, Brazil.

DR. OSWALD S. LOWSLEY, director of the Brady Foundation for Urology at the New York Hospital, has been made a corresponding member of the Association Française d'Urologie and of the Deutsche Gesellschaft für Urologie.

DR. GEORGE T. MOORE, director of the Missouri Botanical Garden, has been elected a member of the executive committee of the Institute for Research in Tropical America.

T. L. JOSEPH, superintendent of the North Central Station of the U. S. Bureau of Mines at the University of Minnesota, has received the J. E. Johnson, Jr., award made by the board of directors of the American Institute of Mining and Metallurgical Engineers.

DR. F. W. SCHULTZ, professor of pediatrics in the medical school of the University of Minnesota, has been appointed a delegate to represent the American Pediatrics Society at the Fifth Pan-American Child Congress to be held at Havana, from February 13 to 20.

A COMPLIMENTARY dinner was given in honor of Dr. Franz Nagelschmidt, of Berlin, by the American Electrotherapeutic Association and the New York Electrotherapeutic Association on December 3, at the Pennsylvania Hotel.

DR. W. H. STEAVENSON has been elected president of the British Astronomical Association in succession to the Reverend C. D. Percy Davies.

Sir Humphry Rolleston, Regius professor of physics in the University of Cambridge, has been elected as the representative of the university on the General Medical Council for five years, in place of Dr. W. L. H. Duckworth, resigned.

The geographical commission recently appointed by Governor Trapp, of Oklahoma, consisting of C. E. Barett, adjutant general, J. B. Thoburn, secretary of the historical society, and Chas. N. Gould, state geologist, organized by electing General Barett chairman and Mr. Thoburn secretary. The committee will meet at the call of the chairman to decide upon matters of geographical interests in Oklahoma.

Dr. Henry R. Kraybill, of the Boyce Thompson Institute for Plant Research at Yonkers, N. Y., has recently been made state chemist and seed commissioner for Indiana. His office will be at the Agricultural Experiment Station, Purdue University.

Commissioner Henry O'Malley, of the U. S. Bureau of Fisheries, has left Washington for the west coast, where he will meet with Commissioner R. B. Scofield, of the International Fishery Commission in the United States-Mexico, for the purpose of developing the investigative program respecting the fisheries and carrying out the provision of the treaty with Mexico.

William Beebe, of the New York Zoological Society, plans to spend the coming winter in studying and collecting animal life in Haiti.

Professor A. J. Scarlett, of the department of chemistry in the University of New Hampshire, is spending a sabbatical year in study at the University of California.

Dr. Nicholas Murray Butler, president of Columbia University, will give the anniversary discourse at the eightieth anniversary meeting of the New York Academy of Medicine on December 16. His subject will be "The Physician: The Larger View."

Dr. Charles P. Berkey, professor of geology at Columbia University, has spoken during the past month on his work as chief geologist with the Third Asiatic Expeditions of the American Museum of Natural History before seven eastern institutions and societies, including the Yale chapter of Sigma Xi and the Geological Society of Washington.

Dr. E. Newton Harvey, professor of physiology at Princeton University, addressed the New York section of the Illuminating Engineering Society on December 9 on "Studies of Luminous Bacteria."

Dr. H. E. Howe addressed the Hampton Roads Chemists' Club of Norfolk, Va., on "Chemistry in American Industrial Progress" on November 12, and on November 18 addressed the Business Secretaries Forum of Chicago on "Association Research."

Nevin E. Funk, operating engineer for the Philadelphia Electric Company, will address the Franklin Institute on December 15 on "Unusual Engineering Features of the Conowingo Dam and Power Plant."

Professor Howard T. Barnes, F.R.S., of McGill University, gave an illustrated lecture on "Ice Engineering" at the University of Michigan on November 23.

On November 20 Professor J. C. McLennan, of the department of physics at the University of Toronto, delivered an address to the Royal Canadian Institute on the subject "The Upper Atmosphere and the Aurora."

Professor H. A. Lorentz, of the University of Leiden, Schiff lecturer in physics, gave a public lecture at Cornell University on November 23, on "Doppler's Principle and its Applications in Astronomy and Physics." After completing his lectures at Cornell early in December Professor Lorentz planned to visit the Pacific coast, and during January and February he will give a course of lectures at the California Institute at Pasadena, returning to Holland early in April.

Carl Akeley, distinguished explorer, sculptor and inventor, has died at Kabale, Uganda, where he had been engaged in explorations for the American Museum of Natural History. Mr. Akeley was sixty-two years of age.

Dr. Walter Wheeler Alleger, emeritus professor of bacteriology in Howard University, died on September 30, aged sixty-six years.

Albert H. Emery, inventor and designer of machines for testing purposes, died on December 2 in his ninety-third year.

The late Ellsworth Bethel (1863–1925), forest pathologist of the U. S. Department of Agriculture stationed at Denver, Colorado, has been honored by the U. S. Geographic Board for his services in increasing general interest in the mountains of Colorado and the west. The peak in Clear Creek County, at lat. 39° 42′ 35″, long. 105° 52′ 40″, formerly known as "Little Professor," has been renamed Mt. Bethel, and will be so designated on a new map of the region, the Montezuma Quadrangle, now in press. Mt. Bethel is 12,696 feet high.

In order to receive consideration at the next meeting of the medical fellowship board to be held the latter part of April, 1927, applications for fellowships in medicine of the National Research Council should be filed by March 1. Applications should be

addressed to the Secretary of the Medical Fellowship Board, National Research Council, 21st and B Streets, Washington, D. C.

ON November 23 a meeting was held in Boston of the executive committee of the Commission on Standardization of Biological Stains. The present members of this committee and the fields they represent are: F. B. Mallory (pathology); R. W. French (Association of Medical Museums); S. I. Kornhauser (zoology); C. L. Wilson (botany), and H. J. Conn (bacteriology), *chairman*. The chief objects of the meeting were to discuss means of expanding the investigations on stains during the coming year and of making the commission publications more useful.

THE Alumni Association of the University of Pittsburgh offered a program at their recent meeting on "The Present Status of the Theory of Evolution," as follows: "The Viewpoint of a Botanist," Dr. O. E. Jennings; "The Viewpoint of a Zoologist," Dr. H. H. Collins; "The Viewpoint of a Geologist," Dr. Henry Leighton; "The Viewpoint of a Zoolographer," Dr. A. E. Ortmann.

THE second Southern California annual Intercollegiate Geological Excursion occurred Saturday, November 6. Professor W. J. Miller, of the University of California, Southern branch, pointed out the features of the igneous rocks in the vicinity of San Gabriel Peak, north of Pasadena, and Professor J. E. Wolff, of Harvard University, indicated the effects of the great 1926 cloudburst at Opid's Camp, where one inch of rain fell in one minute, and ten inches in a few hours. The party included thirty-four geologists from the University of California (Southern branch), California Institute of Technology, Occidental College, Pomona College and Riverside Junior College.

THE eighth field conference conducted under the auspices of the Oklahoma Geological Survey was held in western Oklahoma, the Panhandle of Texas and northeastern New Mexico, November 9 to 18. The object of the conference was to attempt to correlate certain Permian formations in western Oklahoma with those outcropping on the Pecos River of northeastern New Mexico. Thirty-six geologists attended the field conference, including men from Kansas, Colorado, Texas and Oklahoma.

THE thirteenth annual session of the National Game Conference was held at the Hotel Pennsylvania, New York City, on December 6 and 7. Among the principal subjects considered were the preservation of waterfowl, the problem of the wild turkey, the relation of forests to wild animal life, the relation of the introduced pheasant to native game and to the farmer and game problems in Mexico and Canada. The speakers included Dr. E. W. Nelson, chief of the United States Bureau of Biological Survey; J. B. Harkin, Canadian commissioner of parks; Professor Carlos Lopez, director of the division of game, Mexican Department of Agriculture; Shirley W. Allen, forester of the American Forest Association; Seth E. Gordon, of the Izaak Walton League of America, and a number of leading state game commissioners.

IN cooperation with the Burgess Radio Nature League of Westinghouse Station WBZ, the Boston Society of Natural History announces the following radio talks on alternate Wednesdays at 7:30 P. M.: December 15, J. H. Emerton, "Spiders"; December 29, Dr. H. L. Babcock, "Snakes and their Attributes"; January 12, C. W. Johnson, "Some Common Insects of the Household."

THE forty-fifth course of popular medical lectures at Stanford University will be given on alternate Friday evenings at 8 o'clock as follows: January 14, "Causes and Treatment of Hay-fever and Asthma," Dr. Samuel H. Hurwitz; January 28, "The Rôle of Heredity in Disease," Professor C. H. Danforth; February 11, "The Relation of Dental Infection to Disease," Dr. John A. Marshall; February 25, "The Psychology of Disease Symptoms," Professor W. R. Miles; March 11, "What about Irregular Teeth?" Dr. Fred Wolfsohn; March 25, "The Influence of Good Postural Conditions on Health," Dr. Harry L. Langnecker.

FREE lectures and demonstrations have been arranged by the New York Botanical Garden and will be given during the winter in the Central Display Greenhouse, Conservatory Range 2, as follows: December 4, "Plants that produce Rubber," Dr. A. B. Stout; December 11, "House Plants and their Care," Mr. H. W. Becker; December 18, "Some Ornamental Plants of the Sea," Dr. Marshall A. Howe; January 15, "Garden Vegetables and Herbs," Mr. Kenneth R. Boynton; January 22, "The Spices of Commerce," Dr. H. A. Gleason; January 29, "Cacti," Dr. John K. Small; February 5, "Cocoa and Chocolate," Dr. F. J. Seaver; February 19, "The Planting of Flower Seeds," Mr. George Friedhof; February 26, "Some Geological Features of the New York Botanical Garden," Dr. Arthur Hollick.

PLANS for celebrating in 1929 the one hundredth anniversary of the founding of the College of Pharmacy are under way at Columbia University. The faculty hope to inaugurate the college's second century by the establishment of a graduate school, which shall serve as an international center for advanced training and research. It is expected that pharmacists from many countries will gather in New York

for the celebration. Professor Curt P. Wimmer has been appointed to begin the work of historical research in which data will be gathered for the centennial ceremonies.

THE Daniel Guggenheim Fund for Research in Aeronautics has made a grant of $78,000 to the University of Michigan. This will be used to complete the construction of wind tunnels and for the establishment of a new professorship in aeronautics.

THE American Museum of Natural History will receive nearly $1,000,000 from the estate of the late Wood Fosdick, of New York, appraisal of whose estate has just been filed.

SIR JOSEPH VERCO has endowed the *Australian Journal of Experimental Biology and Medical Science* with a gift of £5,000. This sum will be held in trust by the University of Adelaide and the income devoted to sustaining the journal, which will become the property of the university.

THE American Petroleum Institute, on the recommendation of the National Research Council, has granted the Johns Hopkins University $4,000 for immediate use in a research to establish scientific methods for the identification of sulphur compounds in petroleum. The work will be carried on by Dr. Parry Borgstrom, a graduate of the University of California.

THE department of zoology of the University of New Hampshire proposes to make an ecological survey of the fresh waters of New Hampshire. Special attention will be given to water pollution and the effect which this has on animal life. This will run parallel to the study of the pollution of Great Bay and its effect on the distribution of food fishes.

A MOTION reaffirming the intention of the British Association of Chemists to press for the preparation of a register of chemists with a view to confining the conduct of essentially chemical operations to qualified men was carried unanimously at the annual general meeting of the association, held at the Adelphi Hotel, Liverpool, on November 5. The council was further instructed to appoint a special committee to carry this resolution into effect.

UNIVERSITY AND EDUCATIONAL NOTES

GEORGE HERBERT JONES, director of the Inland Steel Company, has given the University of Chicago $415,000 for a new laboratory of chemical research.

ALUMNI of Cornell University have subscribed $200,000 to endow a chair in research work, the incumbent of which will be released from teaching duties in order to spend all his time in research.

A GIFT of $10,000 to found a research fellowship in pure science at Princeton University in memory of Charles Allen Munn has been announced. The donors were Augusta Munn Tilney and Orson D. Munn, niece and nephew of Charles Allen Munn, and T. Hart Anderson and John K. Brachvogel, all of New York.

THE trustees of Dartmouth College have voted to construct a new building which will house the natural science department and will provide the departments of biology, geology, botany and zoology with equipment and facilities that have not been available hitherto.

DR. EDWARD R. WEIDLEIN, director of the Mellon Institute of Industrial Research at the University of Pittsburgh, has announced the establishment of a department of analytical chemistry, which will be supervised by Dr. George D. Beal, formerly professor of analytical and food chemistry in the University of Illinois and now assistant director in charge of the institute's fellowships in the field of pharmaceutical chemistry. Dr. William W. Mills has been selected as analyst in the new department.

DR. BRANDUR J. BRANDSON has been appointed professor and head of the department of surgery at the University of Manitoba Faculty of Medicine, Winnipeg, to succeed Dr. Jasper Halpenny, who resigned on account of ill health; Dr. Daniel S. MacKay has become head of the department of gynecology following the retirement of Dr. Robert M. Simpson; Dr. Tudor J. Jones, Glasgow, has been appointed assistant professor of anatomy.

DR. ADOLPH G. G. DE SANCTIS has been appointed professor of pediatrics at the New York Post-Graduate Medical School and Hospital.

FORBES W. SHAPLEY, lecturer on electrical engineering at the Lauder Technical School, Dunfermline, has been appointed professor of mechanical and electrical engineering at the School of Mines, Dhanbad, India.

DISCUSSION AND CORRESPONDENCE

SCIENTIFIC NAMES AND THEIR CONVENIENCE

IN the *American Naturalist*, Vol. LX, for May, 1926, pp. 275 to 281, is an interesting article entitled "Science and Scientific Names," by Dr. E. P. Felt and Dr. S. C. Bishop. While recognizing the value of this paper and its evident fairness and accuracy, I must entirely dissent from its conclusions as to the possible improvement in the naming of animals and plants.

It was my fortune in Gratz to hear Dr. Rhumbler read his paper advocating the use of prefixes to generic names, by which the systematic position of the genus should be indicated. I believed then as now that there are two serious objections to his own rather clumsy scheme or to any other of like nature. It will never be adopted, and if adopted would only add to the present confusion. For in my judgment the difficulties do not mainly arise from our system of naming, but from the gigantic problem set before us by nature herself. Agassiz used to say: "Try to interpret what really exists." The Linnaean system is as good for this purpose as any other could be, and our whole literature of geographical distribution and of evolution rests upon it. Its chief faults—the needless synonymy and clumsy names—are faults of the workers, not of the system. Our rules are slowly bringing back uniformity in spite of generations of carelessness and of bad taste.

I can not believe that ignorance of the class or family, to be restored by prefixes or other permanent attachments to the word, could possibly help. No one writing in any group fails to know whether the genera he deals with are birds, insects or snakes. That is the least of our troubles. It might have been better if we had allowed duplication in different classes. It is now too late to change, because hundreds of new names have been legally adopted since the animals were separated, in this regard, from plants. It is not necessary to follow the unpleasant precedents of *Edvardotrouessartia, Asmithwoodardia* and the like. When Nichols broke out in *Microstomatichthyoborus* in 1917, I expressed the pious hope that "no one will ever attempt to break this record as to length of generic name." Such well-known records of bad taste as Ameghino's may stand as "awful examples," and the usually senseless "pseudo" may die out in time.

"A name is a name without necessary meaning" and we do not depend on it to fix our ideas of relations. If one does not know the genera of a group, he need not write about it, and a thousand names beginning with *Icro* would be no easier to remember than would a thousand names mustered under the family of *Coccinellidae*.

Our experience shows that it may never be possible in the future to eliminate any of the "nearly 2,000 prefixes of *Para* and *Pseud.*" Priority stands above assumed convenience, for it is a matter to be definitely fixed, whereas convenience, good taste and good sense vary with each individual. This the now rejected substitute names of Cuvier and other really great authors clearly show.

The proposition to indicate species by numerals is wholly untenable. It is hard to remember specific names in general, the commonest, as *gracilis, lineatus, minimus* and the like, especially so.

But to most of us the remembrance of meaningless numerals is a thousand times more difficult. To ascertain the identity of Number 43, with that of Number 86, to know which author got in his Number 46 first, and as to whether the hastily described Number 39 of Coccinella really belonged to that genus are matters which no international commission could or would ever try to handle.

When the species are all in and the definitions all agreed upon, we may have an international world catalogue with a number attached to each species. But as we barely know half of those which really exist, and as half of those we know are "geminates" and so may be reduced to the rank of subspecies, we are not yet ready for a numerical catalogue without agreement as to general validity.

The trouble is therefore not with our system of nomenclature but with nature itself, so prolific with forms of life in comparison with the number of us seriously interested in trying to find out what really exists. Nor is it possible, or in any way desirable, to drop our recognition of the "140,000 more or less current generic names" to return to the meaningless pigeon holes into which species were carelessly dropped by the early authors who had never dreamed that evolution and taxonomy would ultimately be one and the same.

DAVID STARR JORDAN
STANFORD UNIVERSITY

BIOGRAPHICAL NOTE RELATING TO J. J. SYLVESTER

THE recent semi-centennial celebration of the Johns Hopkins University naturally tends to increase temporary interest in the biography of J. J. Sylvester, who occupies a very prominent position in her early history as well as in the history of American mathematics. Hence it may be opportune to note here that in such popular works of reference as the "Dictionary of National Biography" (1898), the "New International Encyclopedia" (1923), the "Encyclopedia Americana" (1920) and D. E. Smith's "History of Mathematics," volume 1 (1923), one finds, under the name of Sylvester, statements equivalent to saying that he was called to the Johns Hopkins University in 1877. On the contrary, the appendix to the first president's report of the Johns Hopkins University states that he was appointed as professor of mathematics on March 5, 1876, and this report states also that he was present at the beginning of the first academic year in October, 1876.

Slight errors as to date are usually of little conse-

quence since the reader can easily find correct information by consulting other authorities, but when such errors are widespread and appear in many of the works which the reader would naturally consult with great confidence, they seem to call for correction in a widely read periodical even if the author of such corrections might by some be put therefore into the class of those who "rail at those who arrive." While the average reader may be satisfied with approximately true statements there are those who seek exact information, and this class deserves attention since it embodies most students to whom the world must look for scientific advances. It was Gauss who insisted on accuracy as regards the last figure in tables of logarithms and brought about a reform relating thereto. It is true that he did not achieve greatness thereby but he exhibited a point of view which is fundamental.

G. A. MILLER

CAPACITY AND FREQUENCY MEASUREMENT BY MEANS OF THE NEON TUBE

IN the June 18th number of SCIENCE there appeared an abstract by Professor Frederick Bedell and Herbert J. Reich describing the use of a neon tube oscillator for obtaining a time axis in the study of alternating current wave forms by means of the cathode ray oscillograph. The oscillator consisted of a condenser which was charged at a constant rate through a saturated vacuum-tube rectifier and discharged periodically and automatically by a neon lamp shunted across the condenser. The method of controlling the frequency of discharge, *i.e.,* changing the rectifier plate current by adjusting the filament rheostat, suggested the possibility of using the plate current as a means of measuring the condenser capacity or the frequency of oscillation.

An analysis of the circuit yields the following simple equation for the frequency in terms of the capacity, plate current and maximum and minimum discharge voltages of the neon tube:

$$f = \frac{I_p - I_o}{(C_c + C_o)\ (E_{max} - E_{min})}$$

where C_o is made up of the neon tube capacity, wiring capacity and coupling capacity to the amplifier or phones, and I_o is the leakage current through the condenser and through the neon tube at the time of discharge. This expression seems to be checked very closely by experiment.

With a preliminary set-up containing low-precision rheostats and meters, readings accurate to within one quarter of one per cent. have been obtained in measuring capacity and frequency. For capacity measurement the frequency is maintained constant by comparison with a standard tuning-fork oscillator. Improvement of the apparatus promises to yield a very simple method of measuring capacity with a degree of accuracy quite sufficient for all ordinary purposes.

HERBERT J. REICH

CORNELL UNIVERSITY

OUR WORLD IN THE MAKING

UNDER the above title Professor Herman L. Fairchild has presented "a brief comparison of some geologic problems analyzed under the two views (Laplacian and Planetesimal) of the primitive earth."[1] Professor Fairchild says:

> An example of innate conservatism, in science instead of religion, is found in the tenacity with which even scientific men are holding to a discredited hypothesis of world origin.

One is entirely justified in assuming that the carefully worked out analysis which follows the above introduction embodies the latest authoritative opinion on the various phases of geological science involved. Under the circumstances the analysis may appear somewhat dogmatic because of the omission of any reference to such contributions to world origin events as those of Jeans,[2] Jeffreys,[3] and others.

Furthermore, certain details of the analysis, such as the discussion of petroleum origin, may appeal to many readers as somewhat out of harmony with this general purport of the paper. According to the analysis one is led to believe that the organic origin of oil is a view engendered by the necessity of a "surficial origin" imposed by the Laplacian hypothesis. There is the further implication that the organic origin of oil can have no general application because "it is not entirely satisfactory for some localized reservoirs of great volume; nor for the peculiar relations in the 'salt domes' of the Gulf coastal plain; nor for the association of the hydrocarbons with crystalline rocks and volcanic phenomena."

It is safe to assume that there is no general recognition of a special problem in the origin of the oil associated with salt domes although the origin of the domes themselves may be considered still a moot question. And again it is generally conceded that in the strikingly few cases of association of hydrocarbons with igneous or metamorphic rocks the association is that of hydrocarbons of exotic origin.

In the light of the overwhelming evidence—less conservative might call it proof—of the organic origin

[1] SCIENCE, Vol. 44, No. 1659, pp. 365–367. October, 1926.

[2] Jeans, James H. Problems of Cosmogony and Stellar Dynamics. Cambridge (Eng.) University Press. 1919.

[3] Jeffreys, Harold. The Earth, Its Origin, History and Physical Constitution. Cambridge (Eng.) University Press. 1924.

of petroleum, it would be of great interest to know more about the "localized reservoirs of great volume" for which the organic origin of oil "is not entirely satisfactory." Certainly, more detailed explanations must be made of the analysis if it is to be of the greatest possible usefulness.

MAURICE G. MEHL

THE UNIVERSITY OF MISSOURI

AN OBSERVATION AT THE TIME OF THE AURORA

BETWEEN 8:45 and 9:00 P. M. to-night (October 14th) we observed a peculiar phenomenon which seems to have some connection with the Aurora Borealis.

The auroral streamers were very strong, and we went into a north room to view them. There was no house illumination: all electric lights were turned off, so as to see the streamers better. Outside there was a moonlight of medium clarity. No perceptible wind was blowing; the air was unusually clear, and the point of observation was exceptionally free from obstructions and street or house lights, being on the top of a treeless hill 725 feet above sea level, in northern New Jersey. The outdoor illuminations against which the phenomenon was observed were a few street lights *about half a mile away*.

While watching the Aurora, my son happened to hold his face close to one of the window panes, so that some of the warm moisture of his breath was precipitated on the glass. Then began the curious thing. The entire area of mist of the glass seemed to begin drifting and blowing at a great rate. It looked for all the world like a tremendous snowstorm. Heavy flakes and wisps of driven snow appeared to be flying past us outside of the pane. It is important to record that *the movement was entirely toward the north and horizontal.* There was *no upward movement,* as one might expect if this had been merely the evaporation of the condensed moisture on the pane.

This movement was visible on no clear pane. As the moisture passed, the movement vanished; as we breathed afresh on the pane, the illusion—if it was one—came back full force.

We waited until the Aurora had ceased, which was about 9:15 P. M. Then, only the faintest trace of the streamers being anywhere visible, we again breathed on the pane; but now no such phenomenon developed.

Will some expert on auroras or radioactivity or relativity or something else kindly enlighten us? Or have we stumbled on some new oddity in this mysterious realm?

WALTER B. PITKIN

COLUMBIA UNIVERSITY

SCIENTIFIC BOOKS

Heteroptera or True Bugs of Eastern North America. By W. S. BLATCHLEY. The Nature Publishing Co., Indianapolis, Ind. 1,116 pages, 12 plates, 215 text figures, Oct., 1926.

THIS is the fourth of Blatchley's books on the systematics of the insect fauna of Eastern North America and upholds the high standard set in the "Coleoptera of Indiana."

The general account of the group, including directions for collecting, is followed by a systematic arrangement tabulating the families, genera and species. The descriptions of the 1,253 species are mostly new, but in the Miridae and Corixidae, owing to the difficulties in obtaining identified material, it was necessary to compile descriptions of some species. A few species are described as new, chiefly from Florida, and a number of tropical species are recorded from Florida for the first time. The nomenclature and classification are those generally accepted, but in a few cases there are changes. With many species the host-plant is given and something of the habits.

The descriptions appear full and sufficient and the synopses, though partly compiled, are well made, altogether easily the best book on the Hemiptera of our country, and it will long be the one most necessary to the student, be he a beginner or a specialist. As with the others of this author's works it will undoubtedly stimulate the study of our insects. One can not refrain from expressing the greatest admiration for the ability and energy which, overcoming numerous obstacles, has pushed this work to such a successful conclusion.

N. BANKS

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE EXTRACTION OF FAT FROM SPECIMENS PRIOR TO CLEARING BY THE POTASH METHOD

IN specimens cleared by the potash method the fat of the superficial and muscular fasciae is partially saponified and appears in the cleared material as opaque, white masses which often prove a serious impediment to accurate observation of the skeletal elements as noted by Strong (1925).[1] After the treatment with potash it is apparently difficult to get rid of the fat, as Strong was unable to find a suitable solvent for these masses and found it necessary to dissect them away.

This difficulty may be obviated by the extraction of

[1] Strong, R. M., 1925, "The Order, Time and Rate of Ossification of the Albino Rat (Mus Norvegicus Albinus) Skeleton," *Amer. Jour. Anat.*, Vol. 36, 313–55.

the fat prior to beginning the treatment with KOH. Of the several common fat solvents tried, acetone was found most satisfactory. It acts quickly and does not injure the tissue or affect its clearing and staining qualities.

The material is first thoroughly fixed in 95 per cent. alcohol and then transferred directly to acetone, being left there for several days, depending on the bulk of the object being treated. Following this treatment, the specimen is transferred directly back to 95 per cent. alcohol for twenty-four hours or longer. After washing in alcohol, the clearing and staining with alizarin may be carried out routinely. In our work we are using a modification of the alizarin method, which results in a progressively selective staining of the bone (Dawson, 1926).[2]

Alden B. Dawson

Department of Biology,
New York University

MACERATION OF GREEN HYDRA

In working with *Hydra viridis* I hit upon a method of maceration that gave results which were better than those obtained by other recorded methods.

For the benefit of those who may be interested, the method is given below.

This involved a fixing fluid composed of equal parts of 40 per cent. formalin, 95 per cent. alcohol and glacial acetic acid. This fluid has been devised and used by Mr. J. B. Looper in the fixation of certain protozoa here in this laboratory. This mixture is placed in a vial that has a mouth of from one half to three fourths inches in diameter. Place the Hydra on a microscopic slide in a very small drop of water. Then draw off as much of the water as possible with a fine pipette, leaving only a film of water surrounding the specimen. Invert the slide over the vial containing the above macerating mixture, in such a manner as to completely cover the mouth of the vial, for eight to ten minutes. At the end of about ten minutes—some specimens requiring a shorter time than others—remove the slide from the vial and add one or two drops of water and draw off. Add water the second time and draw off. Then add a drop of 40 per cent. glycerine. Tease or break up the Hydra with fine needles. Apply the coverglass and examine. If the cells are not separated sufficiently, gently press the coverglass with a needle; however, care should be taken not to crush the delicate cells. At this point, if pressed too hard, the cells are easily smashed and the preparation ruined.

Excellent preparations have been made from freshly collected specimens and specimens which have remained living in the laboratory aquaria for as long as two or three months. Many of these preparations show fine cell structure.

J. R. Mundie

Miller School of Biology,
University of Virginia

SPECIAL ARTICLES

GROWTH AND TRANSFORMATION OF PARASITIC GLOCHIDIA IN PHYSIOLOGICAL NUTRIENT SOLUTIONS

In experiments completed at the U. S. Bureau of Fisheries Biological Station at Fairport, Iowa, by us this summer, artificial nutrient solutions were prepared in which the glochidia of the freshwater mussel, *Lampsilis fallaciosa* Smith (known as the Creeper or Slough Sand-shell), were carried through their various developmental stages from glochidium to the free-living juvenile mussel. The glochidia of this species of freshwater mussel are parasitic on the gills of the short-nosed gar, *Lepisosteus platostomus* Rafinesque, for a period varying from two to several weeks, during which time the glochidia undergo marked internal changes and differentiations and emerge from their cysts at the end of this sojourn on the fish as free-living juvenile mussels. The nutrient fluid was perfected so that this period of parasitic life on the fish could be replaced by a period *in vitro,* during which the growth and differentiations ordinarily made by the glochidium in the cyst could be studied and controlled.

The glochidia used in these first series of experiments were dissected out of their cysts on the gills of artificially infected gar, eighteen and ninety-six hours after encystment was begun. The freed glochidia were transferred at once to the solutions in which their development was to be followed. Glochidia removed from the cyst eighteen hours after attachment to the fish gill differed little if at all in appearance from ripe glochidia in the maternal marsupium. Glochidia removed at the end of ninety-six hours showed considerable development of the organ anlagen, although the glochidia were still in a very embryonic stage, as was evidenced by the presence of a large portion of the larval mantle cell mass. In the most favorable solution tested the glochidia were carried through the twelfth day in the solution, at which time their development equalled that of control glochidia which had been carried on the fish and were just ready to emerge from their cysts. When this stage was reached by the glochidia *in vitro* they were transferred from the nutrient solution to river water in

[2] Dawson, A. B., 1926, "A Note on the Staining of the Skeleton of Cleared Specimens with Alizarin Red (sodium alizarin monosulphonate)." *Stain Technology* (to appear in the October number).

which they made their final transformation in less than a half hour. In actual time the transformation stage was reached by the glochidia *in vitro* more quickly than by the glochidia on the fish, but there may be several factors involved in this comparison. Certainly, however, the growth and development of the glochidia *in vitro* was not delayed.

Juvenile mussels which transformed in these artificial nutrient solutions were kept in river water for three weeks after transformation without the loss of a single individual, the juvenile mussels making excellent growth of both shell and soft parts during that time and seeming in every way to be very vigorous. This was a bit surprising, as there is known to be a rather high mortality, on the contrary, among mussels during the first few days after leaving the fish following the natural parasitic cycle.

The several series of glochidia carried in the various nutrient solutions *in vitro* showed that parasitic life on the fish is not essential to development and transformation if the proper food substances be supplied in the proper environment; that the glochidium receives by its encystment a much-needed protection against certain bacterial and protozoan enemies; and that the glochidium is a true parasite while on the fish, receiving essential food substances from the host fish. This last statement was repeatedly tested in a variety of experiments and the so-called protective physiological solutions containing only inorganic salts were neither adequate to produce growth and differentiation nor to maintain glochidia already well started on their way to transformation.

The successful solutions contained sodium chlorid, potassium chlorid, calcium chlorid, sodium bicarbonate, dextrose and a mixture of amino-acids, together with small quantities of phosphates and traces of magnesium salts. Detailed data of these experiments as well as experiments on glochidia taken directly from the maternal marsupium are to be published.

M. M. Ellis
M. D. Ellis

Department of Physiology,
University of Missouri

CRITICAL POTENTIAL MEASUREMENTS: A CORRECTION FOR HIGH-EMISSION CURRENTS

In experiments on critical potentials the voltage E_1 (Fig. 1) applied to a filament and grid is usually measured by means of the potentiometer R_1R_2.

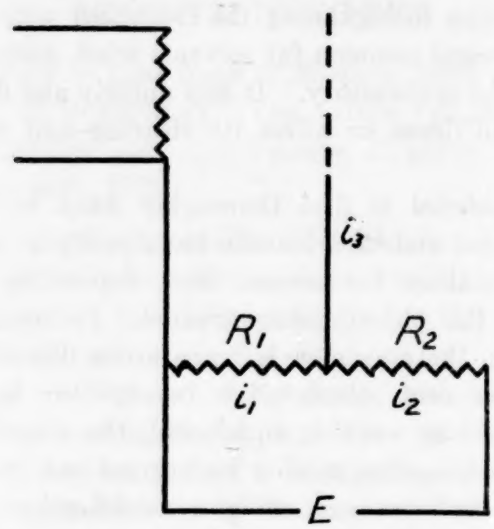

Fig. 1

When the current I_3 is zero, then

$$E_1 = \frac{R_1}{R_1 + R_2} E \quad (1)$$

However, if the current I_3 is large, then

$$E_1 = \frac{R_1}{R_1 + R_2}[E - I_3R_2] \quad (2)$$

This equation is derived from Kirchoff's first and second laws

$$E = E_1 + E_2 \text{ and } I_2 = I_1 + I_3 \quad (3)$$

and Ohm's law

$$E_1 = I_1R_1 \text{ and } E_2 = I_2R_2 \quad (4)$$

Combining equations (3) and (4) and simplifying gives equation (2). In this derivation the laws for networks have been applied to conductors only, and no special assumption has been necessary regarding the resistance of the filament-grid space.

Equation (2) has been tested with a four-electrode tube containing helium. The following table shows clearly that the correction is a necessary one, when I_3 becomes large.

Critical Potential of Helium at 0.3 mm Pressure

I_3 microamperes	Experimental Critical Potential in Volts uncorrected	corrected
2.4	21.01	21.01
160	21.63	21.24
800	23.50	21.39
	Average	21.21

A further correction for initial electron velocity and contact potential has to be applied to this value.

In another test a portion of the voltage E_1 has been measured with a standard cell, and it was found that equation (2) is correct.

I wish to thank Messrs. R. H. Dalton and W. P. Baxter for making the experimental tests described above.

George Glockler

Gates Chemical Laboratory,
California Institute of Technology